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By J. W. Powell.

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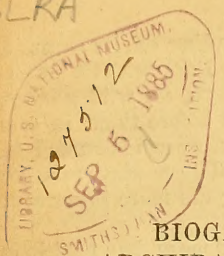

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BIOGRAPHICAL NOTICE OF ARCHIBALD ROBERTSON MARVINE.

By J. W. POWELL.

(Read June 3, 1876.)

Mr. Archibald R. Marvine was born at Auburn, New York, Sept. 26, 1848. When a youth he attended the military school at Sing Sing, and subsequently the School of Technology at Philadelphia. Leaving the latter he entered the Hooper Mining School of Harvard University, from which he graduated in 1870, when he was appointed instructor in the same school, a position which he held until July, 1871.

In 1869 Professor J. D. Whitney, of Harvard University, conducted a party of students on a trip among the Park Mountains of Colorado for the purpose of making practical studies in geography and geology. On this trip Mr. Marvine, who was one of the party, was instructed in both these branches. The field of study was happily selected, being a portion of the Park Mountain region including South Park and the lofty mountains with which it is walled. The geographic features of the region in its larger outlines are simple. On the north is the great Colorado Range, a wilderness of crags and peaks; on the south the great group of mountains of which Pike's Peak is the culmination; on the east the Front Range, a low, broad, flat-top mountain mass; on the west the Park Range.

The Colorado Range along its main course west of Denver has a north and south axis, but near its southern end it sweeps westward in a great curve and abuts against the Park Range, and this southern curve forms the boundary between North and Middle Parks. Just here where the Park and Colorado Ranges unite, South Platte River heads in snow banks that even midsummer suns cannot destroy, and running eastward at the foot of the Colorado Range, it breaks through the Front Range by a deep, narrow cañon set with crags and pinnacles. In the midst of the Park are low subsidiary ranges chiefly trending north and south, and between these ranges there are long, narrow valleys heading in the Pike's Peak Mountains and stretching northward to the foot of the great Colorado Range, where the streams that meander through these valleys yield their waters to the South Platte.

The party climbed Pike's Peak, and, standing on its summit, the district of country just described—South Park with its mountain walls, its interior ranges, its deep valleys, its wild gorges, its silver rivers and its crystal lakes, was all before them in one grand view. In such a field the young men were instructed in determining latitudes and longitudes, in determining relative positions by triangulation, and in delineating the more important topographic features.

But mountains and valleys have something more than positions and magnitudes to interest the student of nature—they have structure; and in this structure are revealed the great facts of geology relating to displacement, degradation, sedimentation, metamorphism, and extravasation; and the field of study presented many interesting facts in each of these categories of phenomena. The great ranges stood before them to attest to the displacement or corrugation of the Earth's surface in mountain wrinkles, and these mountains are seen to be but residuary fragments of upheaved masses as plainly giving evidence of degradation as they do of displacement; while the methods of degradation by the wash of rains, by the sapping of cliffs, by the corrosion of water channels, and by the sculpture of ice, could be studied on every hand.

To MARVINE, the summer's study was rich in results. He learned that a mountain was more than a mountain, that it was a fragment of earth's history.

In the summer of 1860 Mr. MARVINE was appointed assistant geologist to attend the celebrated Santo Domingo Expedition, and on his return he prepared a brief report on the economic geology of some portions of that island which he visited. This was published with the report of the Commission of Inquiry to Santo Domingo by authority of Congress. It was a special and brief study, and contains little of general interest to the geologist.

In 1871 he received an appointment as astronomer to the Wheeler Expedition, in which capacity he served for several months, and then continued several months longer as geologist. His report on the geology of a district of country through which he passed, embraced in southern Nevada, northwestern Arizona, and southern California, has lately been published as one of the papers in Volume III. of the United States Engineer Reports of the Explorations and Surveys west of the 100th Meridian, Lieut. GEORGE M. WHEELER in charge. The region of country studied by Mr. MARVINE during these months of field service was one of great complexity. On one side of his general route of travel an extensive series of sedimentary formations are revealed, embracing Tertiary, Mesozoic, and Paleozoic groups; on the other, low mountain ranges are seen rising from a desert sea of sand, the ranges being composed of more ancient sediments and schists. The former is a portion of the Plateau Province, the

latter a portion of the Desert Province. Both the Plateau sediments and the Desert Range rocks are greatly masked by beds of basalt and other extravasated material. Back and forth across the zone separating the plateaus from the Basin Ranges he passed in long rapid marches, studying now the one, now the other region, and ever examining the volcanic phenomena by which he was surrounded, and yet his keen and well-trained eye caught the more important topographic and geologic features, and he has given in his report a singularly clear and comprehensive account of the region when we consider the circumstances under which it was made. He recognized the principal structural characteristics of the plateaus, and in some instances the structure of the Basin Ranges. He recognized that he was travelling on the border between the two. He discovered the sequence of the sedimentary groups of the Plateau Province, and collected sufficient paleontological evidence to demonstrate his conclusions. He closes this report with the following characteristic and vivid description of the Desert Range Province: "It is a great depressed mountainous region, deeply buried beneath the sediments which have been eroded from its own mountains by a surrounding sea. This action has filled the valleys, gradually covered the foot-hills, and, removing the *dêbris* from the mountain bases as fast as formed, has left their clean and sharp-cut tops projecting above the surrounding plain without the usual accompaniment of foot-hills and border region which surround nearly all ranges, the changes on the contrary from mountain slope to the gentle incline of the plain being generally very abrupt. The mountains seem to be of ancient plutonic or metamorphic rocks, or else of lavas; the former more often forming ranges, of which the majority trend about northwest and southeast; the latter more frequently occurring as striking isolated peaks. The detrital filling varies from gravels traceable to the rocks of adjacent hills, to the finest of alluvium, the dust of which the winds often carry for miles into Northern Arizona. It is sparsely sprinkled with a dreary vegetation, composed principally of scattered individuals of many species of mimosæ and of cacti, the most striking of the latter being the tall and isolated *Cereus giganteus*.

"To stand on the edge of the Piñal Mountains upon a quiet day and look off upon these wonderfully silent and arid plains, with their innumerable 'lost mountains' rising like precipitous islands from the sea, all bathed in most delicate tints, and lying death-like in the peculiar, intangible afternoon haze of this region, which seems to magnify distant details rather than to subdue them, impresses one most deeply. The wonderful monotony seems uninclosable by an horizon; and one imagines the scene to continue on the same and have no end. Though the gulf and ocean are three hundred miles away, yet here is the continent's real southwestern border.

"Were the waters of the Gulf of California suddenly changed to gravel and sand, with its precipitous and rugged mountain islands left projecting from the surface as now, there would be so [produced an excellent representation of these deserts, and, geologically speaking, it is but as yesterday that precisely the same action was going on over all this enormous area as is now in progress in the more confined region of the Gulf. The slow elevation which has in part probably caused the gradual receding of the waters, may still be extending the area of our continent."

Up to this time Mr. MARVINE'S geological studies had been somewhat general and desultory—necessarily so from the conditions under which they were made. But in the following summer he was engaged with Professor PUMPELLY in the Keweenaw Copper Region on the shore of Lake Superior, and his report on this work was published by authority of the Legislature of Michigan.

His work during this season was confined to a narrow area, and was special, and is a fine example of painstaking, minute geological study. It consisted in tracing a series of geological beds through two or three counties lying along the lake shore. This was done by careful triangulation and levelling of the general area, and the following of the dips and strikes of the beds and measuring their thicknesses, and by carefully analyzing their lithologic and mineralogic constituents. The entire work is presented in a series of sections and tables carefully and skilfully arranged, with a general discussion, sufficiently elaborate to set forth the relations of all the important facts. His work is thus a fine model for what must be done throughout the Lake Superior region before any general discussion of the geology of the district can be made which will have permanent value.

Mr. MARVINE thus demonstrated that his experience in the fragmentary work incident to a geological reconnoissance had not led to such habits of hasty conclusion as to incapacitate him for the more thorough work of a geological survey.

Yet up to this time his work was but fragmentary, but in March, 1873, he was given a position as geologist in the corps of the U. S. Geological and Geographical Survey of the Territories under Dr. HAYDEN.

During the following season his field of research embraced the region of Middle Park in Colorado Territory, including the mountains by which it is inclosed, and extending eastward to the Great Plains, embracing an area of about 5000 square miles. How thoroughly his work was done, how clearly the geography and geology of the region was set forth in his report, and what important conclusions he reached in mountain structure and geological history, can only be fully appreciated by a careful and thorough reading of his report. It is impossible to understand a discussion of the geological structure of a region without first fully grasping the character and magnitude of its geographic

features. Geology is revealed in topography. The details of topography may seem simple, and taken severally may be simple, but in groups they become extremely complex, and few persons readily comprehend the order and system with which topographic features are gathered about the great geological structure lines of a region. It is easy to be lost in a maze of hills and a confusion of mountain peaks unless the grand topographic forms on which the hills and mountains are sculptured are seen with a mental vision that reaches further than the eye. He who can see a mountain range, or a river drainage, or a flock of hills, is more rare than a poet. In anatomy there is a place for apophysis and sinus, for arch and foramen; so in a mountain range there is a place for peak and valley, a place for amphitheatre and cañon, and the geologist who seeks to reveal the embryology and growth of a mountain range must first become thoroughly familiar with its anatomy. A hill may be a hundred or five hundred feet high, a mountain a thousand or ten thousand feet in altitude, and these may be interesting facts, but they give no clue to hill or mountain structure, and have values of the same order as the size of animals in systematic zoölogy. Not every geologist has been able to understand the geography of a region studied, and very few indeed have been able to describe the geography of a district. Something more is needed than to make mention of mountains and hills, of valleys and cañons; the order in which they are arranged must be set forth, and their relations to the general structure must be explained.

Mr. Marvine went into a region which to the common eye would seem but a wild confusion of mountains and valleys, of crags and gorges, but in that single summer's study he discovered the sublime order in which the mountains and hills and ridges were placed, and in the first few pages of his report he sets forth this order in language clear and simple, giving a plain bird's-eye view of all that five thousand square miles of mountain crag and cañon gorge. Then he divides the area into three national geographic divisions, and hence geologically distinct; the zone of ridges separating the plains from the mountains or mountain border region; the great range and Middle Park. In the first he found a series of sedimentary groups having a total thickness of more than 7000 feet, and a natural grouping was first discovered; then he studied the overlaps and out-thinnings, the changes in conditions of sedimentation, the grand displacements due to orographic movements, and the minor concomitant flexures and faults. All of these facts he presents in orderly arrangement with appropriate diagrams and sections. His chapter on this topic is full of facts and yet it never wearies the reader, for every fact has a meaning. The geological literature of America is greatly burdened with inconsequent facts: A geologist repairs to the field, finds a sandstone, measures it and it is ninety-nine

feet in thickness; the next day he finds a limestone, measures it and it is a hundred and one feet in thickness. He returns and reports, and his report has the same value as that of the zoölogist who went into the woods and found an animal with four legs and a tail, and the tail was four inches long as determined by careful estimation or barometric measurement. But the thickness of the limestone or the length of the animal's tail are facts of very little value except as related to those of greater significance.

The geological report which has no reference to geological structure is dreary reading, and less interesting as a recreation than a table of logarithms; while the latter has a logical arrangement and may serve some important purpose, and the student may find a meaning in the figures, the former is purposeless and meaningless. Some of our geological literature could be burned and no harm done. O that a pope would rise and a holy catholic church of geologists—a pope with will to issue a bull for the burning of all geological literature unsanctified by geological meaning. Then there would remain the writings of those inspired with the knowledge that a mountain has structure, that every hill has an appointed place and every river runs in a channel foreordained by earth's evolution, and MARVINE's work would be a book of genesis in the bible of the geological priesthood. To those members of the Society who have not made a special study of American geology and its literature, this statement may seem an exaggerated panegyric; but let him wade by months and years of study through the volumes of valueless records by which geological literature is encumbered and then take up MARVINE's paper on the Middle Park district and his appreciation will be meagre, his enthusiasm cold if he does not exclaim that order has moved on chaos.

In his third chapter Mr. MARVINE discusses the structure of the great Colorado Range. Two great facts appear: first, that the range is composed of metamorphic schists and granites having a detailed structure independent of the grand topographic forms now existing, but related to a topography antecedent to the present and which was buried by encroaching waters prior to the upheaval of what we now know as the great Colorado Range; and, second, that the great orographic movements producing the present grand features of the country brought up once more that ancient and buried land; and the present drainage system, determined by these later upheavals, while conforming to the later structure, was superimposed on the earlier; and his facts are assembled in such manner in this chapter that his grand conclusions are fully demonstrated.

His fourth chapter is on the Middle Park proper. This is an exceedingly complex piece of geology, and to properly characterize the chapter it would be necessary to substantially reproduce

he was especially attracted to chemical physics, and had he lived to continue his labors as a geologist, his predilection for these studies would doubtless have greatly modified all his geological investigations.

Personally and socially his modesty was great, and this trait of character is evinced in his writings; and those who knew him intimately loved him for his honesty, a trait of character that appeared everywhere in his collection of facts and in every step made toward conclusions, and he leaves behind many to mourn the loss of his genial presence, and the labors of his vigorous and comprehensive mind.

it. The vestiges of earth's history found here where the sea and clouds have alternate dominion over the land, are set forth in a manner simple and perspicuous.

One very important conclusion reached by Mr. MARVINE must not be neglected, viz., that the ranges about this park were not upheaved as great appressed folds, but that the upheaval was along lines by faulting, or narrow zones by abrupt flexure—an important characteristic of displacement throughout much of the interior of this continent—and these facts are eventually destined to modify if not revolutionize the geological theories concerning the constitution of the earth.

After the preparation of this report, in the spring of 1874, Mr. MARVINE again returned to Colorado Territory for the purpose of extending his geological studies in the region west of Middle Park. From my intimacy with Mr. MARVINE I know well with what eagerness he resumed these studies and how anxious he was to pursue lines of investigation suggested by facts discovered in his previous work. And so, fired with an enthusiasm for the discovery of the secrets of the mountains, he plunged into the wilderness far away from civilization. All that summer long he toiled, climbing only where the geologist would climb, seeing only what the geologist could see; and still eager for more knowledge, he pressed his work until the desolate mountains were mantled with the winter's snow, and a further study of geology was impossible; then he returned. But the labor and hardships of the summer's travel, though unheeded at the time, were too great for his physical endurance, and on his return he was prostrated with the disease that held him in firm grasp for many long weeks. Slowly during the following spring he partially recovered, and then, although he was not able to work with vigor, those with whom he was more intimate and who loved to talk with him on the subjects of his investigation, learned the great results and significance of the past year's study. Not recovering health and strength, he was unable to return to the field or to prepare the results of his former work for publication; still he worked on his map, coloring it for the purpose of showing the geographic distribution of the geological formations within his field of study, and this was done with elaboration. Then he thoroughly arranged and systematized his notes and determined his plan of discussion. Here his work ended, for health and strength failed again, and he relapsed into a condition that his friends soon found was hopeless. On the second of March, in the city of Washington, MARVINE, the young, enthusiastic, and brilliant geologist, died.

Mr. MARVINE'S preparation for work as a geologist was very thorough, and for one of his age, very broad. In chemistry, astronomy, and physics, his studies had been careful and thorough, and his grasp of these subjects was comprehensive and firm; but

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